

ACIDITY OF HALF-SOUR DILL PICKLES

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ABSTRACT

Factors affecting the acidity of half-sour dill pickles prepared by recipes published in cookbooks were investigated. Recipes varied widely in ingredient proportions and procedures. The pH of cucumber-brine homogenates simulating unfermented products exceeded pH 4.6 with 10 of 14 recipes examined. The pH of fermented half-sour pickles was excessively high if products contained insufficient vinegar and were prepared with boiling rather than cool brine.

INTRODUCTION

HALF-SOUR dill pickles, also referred to by such names as new or overnight kosher dill pickles, have gained widespread acceptance in the United States in recent years (Etchells et al., 1976). These products originated as traditional eastern European specialties, and many recipes for their preparation at home have been published.

Because of the relatively low acidity of half-sour dill pickles, with some commercially prepared samples exceeding pH 5.2 (Etchells et al., 1976), the Food and Drug Administration has expressed concern about the safety of this product (Gardner, 1976). Several outbreaks of botulism have been associated with home-made pickles in the United States (Meyer and Eddie, 1965; Mundt et al., 1966). Ito et al. (1976) have demonstrated that *C. botulinum* is capable of growth and toxin formation in cucumber puree adjusted to pH values of 5.0 or higher, but not at pH 4.8 or below.

Because of these indications of potential hazard, we conducted studies to determine whether published recipes for the preparation of half-sour pickles, or inappropriate modifications thereof, might yield high pH products. The results of these studies are reported herein.

MATERIALS & METHODS

PICKLING-TYPE cucumbers were purchased at local produce markets or obtained from Fordhook Farms, The W. Atlee Burpee Co. experiment station in Doylestown, PA (cultivar specified). Fourteen published recipes for half-sour dill pickles, representing typical formulations and procedures, were selected for study. A model system was devised to simulate unfermented products made according to these recipes and to permit the estimation of their equilibrium pH, acidity, and salt content. Cucumber puree, homogenized in a Waring Blendor at high speed for 2 min, was combined with brine containing water, salt and vinegar (50 grain; all vinegar additions described herein refer to this strength) as specified by the recipes. Cucumber-brine combinations were mixed with a magnetic stirrer for 10 min before being analyzed. This model system yielded pH and titratable acidity values similar to those obtained with corresponding unfermented brined cucumbers which had been pasteurized by immersing jars in a boiling water bath for 10 min, cooled and equilibrated at 25°C for 7–12 days prior to analysis.

The effect of using hot or cold brine on acid formation in fermenting half-sour dill pickles was investigated with recipes D and E (Table 1) and two cucumber cultivars: Burpee Pickler and Liberty Hybrid. Brine was prepared by pouring boiling or cool distilled wa-

ter over the cucumbers and other ingredients contained in quart jars. Jars were loosely closed to permit free gas exchange or tightly closed to obtain a gas-tight seal. Samples were incubated at 21° or 25°C for 3 and 7 days before being analyzed for pH and titratable acidity.

Pickle samples for analysis were homogenized for 2 min at low speed in a stainless steel semi-micro blender jar. The pH of brine or homogenate samples was measured with an expanded scale pH meter and glass and fiber junction calomel reference electrodes, standardized with pH 4.00 buffer. The titratable acidity of brines and pickle homogenates was determined by titrating a 10-g sample, diluted with 40 ml distilled H₂O, with 0.1N NaOH to a pH 8.1 end point. Sodium chloride was determined as chloride by AgNO₃ titration with a chromate indicator (2.109, AOAC, 1970).

RESULTS & DISCUSSION

KEY ELEMENTS of 14 typical recipes for home-made half-sour dill pickles are summarized in Table 1. These recipes vary greatly in specifications for added vinegar (if used at all), added salt, and the proportion of cucumbers to brine (pack-out ratio). The recipes also differ in their approach to certain important steps of the pickling process, i.e., the addition of hot or cool brine to cucumbers, the use of crocks, loosely closed or tightly sealed jars, and the use of fermentation times varying from 2–3 days to 3 wk at room temperature.

Since half-sour dill pickles may be consumed after little or no fermentation, we estimated the pH, acidity and salt content of unfermented products corresponding to the recipes described previously by means of the model system (Table 1). The pH of many of these simulated products, including some containing added vinegar (F, G and J), would be high enough to permit the growth of *C. botulinum*, assuming other conditions to be favorable for growth. Etchells et al. (1976) recommended an acidification level sufficient to lower the product pH to 4.5–4.6 or below for satisfactory preservation during refrigerated storage. Only 4 of the 14 recipes yielded unfermented products having pH values of 4.6 or lower. These corresponded to acidification levels equivalent to 1–2 tablespoon (15–30 ml) of vinegar per quart. Etchells et al. (1976) estimated that 15–20 ml of vinegar per quart would be required for the smaller sizes of pickling cucumbers which are higher in pH, more highly buffered, and can be packed at a higher cucumber-to-brine ratio than larger cucumbers. We have found that the quantity of vinegar required to lower the pH of blended cucumbers to 4.6 in the model system can be as high as 5.3 ml per 100g for some highly buffered cucumber samples. This is equivalent to a level of addition of 28 ml vinegar per quart of brined cucumbers for a pack-out ratio of 60/40 or 33 ml per quart for a pack-out ratio of 70/30, the highest encountered in this study.

The salt content of simulated unfermented half-sour dill pickles varied between 0.7 and 3.1% for the unacidified products which had pH values between 5.5 and 5.7. Roberts and Ingram (1973) reported that at least 5–6% salt would be required to inhibit the growth of *C. botulinum* in this pH range. Data cited by Riemann et al. (1972) suggest that the salt contents of the higher pH acidified products (recipes F, G and J) would probably be sufficient to inhibit the growth of *C. botulinum*.

Since the acidity of half-sour pickles depends in part on

Table 1—Published recipes for half-sour dill pickles

Recipe	Reference	Proportions (parts by weight)				Brine addition	Container & tightness of seal	Fermentation time (days)	Composition of unfermented products ^c		
		Cucumber	Water	Vinegar	Salt				pH	Titrateable acidity (meq/100g)	NaCl (%)
A	Stechishin (1975)	135	100	0	7.5	Boiling ^b	Jar, tight	2–3	5.5	0.8	3.1 ^d
B	Levinson (1965)	155	100	0	4.0	Cool	Crock	3–4	5.6	0.9	1.5 ^d
C	Berg and Waldo (1955)	135	100	0	5.0	Cool	Jar, NS ^a	10	5.6	0.8	2.1 ^d
D	London and Bishov (1971)	135	100	0	5.0	Cool	Jar, tight	14	5.6	0.8	2.1 ^d
E	Woman's Day (1966)	135	100	0	1.6	Cool	Jar, tight	14	5.7	0.8	0.7 ^d
F	Bar-David (1973)	138	100	2.1 ^b	8.4	Cool	Jar, NS	"few"	5.0	1.4	4.0
G	Froud (1972)	220	100	3.0 ^b	9.0	Cool	Jar, NS	7–21	5.0	1.6	3.3
H	Edlin and Spector (1964)	216	100	8.4	5.6	Hot	Crock	NS	4.5	2.9	2.2
I	Lesem (1975)	94.5	100	7.1	6.4	Boiling	Jar, loose	NS	4.1	3.4	3.9
J	Grossinger (1958)	194	100	1.6	8.4	Cool	Crock or jar	5	5.2	1.4	3.4
K	Leonard (1951)	216	100	3.7	8.4	Boiling	Jar, loose	8–10	4.7	2.3	3.0
L	Leonard (1951)	130	100	3.8	5.0	Boiling	Jar, loose	10	4.6	2.4	2.6
M	Reasoner et al., (1963)	73	100	6.3	8.4	Cool	Crock	14	4.2	3.3	5.0
N	Etchells et al., (1976)	181	100	4.2	5.8	Cool	Jar, NS	Refrigerated	4.7	2.3	2.6

^a NS = not specified^b Optional^c Simulated with cucumber puree-brine combination^d Calculated from recipe

the fermentation process, we investigated the effects of variations in pickling methods, as described in Table 1, on acid formation during fermentation. We found that products prepared with boiling brine were consistently higher in pH and lower in titrateable acidity than were the same products prepared with cool brine (Table 2). Fermenting cucumbers lagged behind the brine in pH and titrateable acidity but followed the same trends. We observed the hot brine effect with two cucumber cultivars—Burpee Pickler and Liberty Hybrid, when recipe D was used instead of recipe E, and when samples were fermented at 25°C rather than at 21°C. Pickles prepared with hot brine remained above pH 5.0 even after 1 wk at 21°C. At the higher incubation temperature, the fermentation proceeded more rapidly, pH values falling below 4.6 after 1 wk. Lid tightness had no effect on pH or titrateable acidity in these experiments. The addition of boiling water to jars containing cucumbers, salt and other ingredients might be expected to greatly reduce their microbial load, thereby delaying and perhaps modifying the fermentation and inhibiting acid formation in the product. These results suggest that the practice of preparing unacidified half-sour pickles with boiling brine may be unwise since the product pH may be above 4.6 for an extended period of time.

Several recent publications for home picklers have indicated that "...all pickled products should be heat processed" (i.e., home canned) as a "safety measure" (McNair, 1975) or to prevent spoilage (Kendall, 1976). Guthrie and

Guthrie (1974) suggest that picklers wishing to home can a pickled product for which no processing time is specified might use 5–15 min in a boiling water bath. Such instructions are inappropriate for half-sour pickles which may exceed pH 4.6 if insufficient vinegar is added and the fermentation is retarded, i.e., by the addition of hot brine or by refrigeration (Etchells et al., 1976). To avoid a potential risk of botulism, cookbooks and other sources of home pickling information should make a sharp distinction between half-sour dill pickles which should never be thermally processed at 100°C and other more acidic pickled products which may be heat processed.

REFERENCES

- AOAC. 1970. "Official Methods of Analysis," 11th ed. Association of Official Analytical Chemists, Washington, DC.
- Bar-David, M. 1973. "The Israeli Cookbook," p. 204. Crown Publ. Inc., NY.
- Berg, G. and Waldo, M. 1955. "The Molly Goldberg Jewish Cookbook," p. 99. Pyramid Books, NY.
- Edlin, R. and Spector, S. 1964. "My Jewish Kitchen," p. 398. Live-right Pub. Co., NY.
- Etchells, J.L., Bell, T.A. and Moore, W.R. Jr. 1976. Refrigerated dill pickles—questions and answers. *Pickle Pak Science* 5(1): 1.
- Froud, N. 1972. "The International Jewish Cookbook," p. 270. Stein and Day, NY.
- Gardner, S. 1976. Pickled, fermented, acidified and low-acid foods. Proposed good manufacturing practices. *Federal Register* 41(143): 30458.
- Grossinger, J. 1958. "The Art of Jewish Cooking," p. 147. Random House, NY.

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Table 2—Effect of hot brine on the acidity of fermented half-sour dill pickles^a

Brine added	Trial	pH				Titrateable acidity ^b			
		Brine		Pickle		Brine		Pickle	
		3 days	7 days	3 days	7 days	3 days	7 days	3 days	7 days
Hot	1	5.2	5.2	5.6	5.2	1.7	2.9	1.1	2.0
	2	5.4	5.4	5.6	5.4	1.4	2.8	1.2	1.9
Cool	1	4.2	3.9	5.1	4.3	2.2	5.0	1.7	2.8
	2	4.2	4.1	5.0	4.5	3.3	4.8	1.9	2.9

^a Prepared with Liberty Hybrid cucumbers according to recipe E and fermented at 21°C in loosely closed jars^b Milliequivalents per 100g

- Guthrie, R.S. and Guthrie, J.S. 1974. "A Primer for Pickles, A Reader for Relishes," p. 14. Privately published by authors. Distrib. by Scribner, NY.
- Ito, K.A., Chen, J.K., Lerke, P.A., Seeger, M.L. and Unverferth, J.A. 1976. Effect of acid and salt concentration in fresh-pack pickles on the growth of *Clostridium botulinum* spores. *Applied and Environmental Microbiology* 32(1): 121.
- Kendall, P. 1976. Making pickles at home. No. 9.304. Colorado State University Extension Service, Fort Collins, August 15.
- Leonard, L.W. 1951. "Jewish Cookery," p. 423. Crown Publishers Inc., NY.
- Lesem, J. 1975. "The Pleasures of Preserving and Pickling," p. 108. Knopf, Westminster, MD.
- Levinson, L.L. 1965. "The Complete Book of Pickles and Relishes," p. 99. Hawthorne Books, Inc., NY.
- London, A. and Bishov, B.K. 1971. "The Complete American-Jewish Cookbook," p. 518. Thomas Y. Crowell Co., NY.
- McNair, J.K. 1975. "All About Pickling," p. 16. Ortho Book Division, Chevron Chemical Co., San Francisco.
- Meyer, K.F. and Eddie, B. 1965. "Sixty-Five Years of Human Botulism in the United States and Canada." The University of California Printing Department, Berkeley, CA.
- Mundt, J.O., McCarty, I.E. and Williams, D.B. 1966. The safety of home-made pickles and relishes. Tennessee Farm and Home Science Progress Report No. 57, Agricultural Experiment Station, University of Tennessee, Knoxville, p. 6-8.
- Reasoner, F., Mason, L., Cox, M. and Tribble, M. 1963. Pickles and Relishes. B188, p. 13. The Agricultural and Mechanical College of Texas, Texas Agricultural Extension Service, College Station.
- Riemann, H., Lee, W.H. and Genigeorgis, C. 1972. Control of *Clostridium botulinum* and *Staphylococcus aureus* in semi-preserved meat products. *J. Milk Food Technol.* 35: 514.
- Roberts, T.A. and Ingram, M. 1973. Inhibition of growth of *C. botulinum* at different pH values by sodium chloride and sodium nitrite. *J. Food Technol.* 8: 467.
- Stechishin, S. 1975. "Traditional Ukrainian Cookery," 7th ed, p. 467. Trident Press, Winnipeg.
- Woman's Day. 1966. "Encyclopedia of Cookery." Vol. 6. "Jewish Cookery," p. 993. Fawcett Publications, Inc., NY.

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